Aerosol Correction for NPOESS VIIRS Sea Surface Temperature

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Abstract

Satellite sea surface temperature (SST) retrieval has been available for nearly three decades. The effects of high aerosol concentrations on SST retrievals are not well characterized and are a significant concern in the Visible/IR Imager/Radiometer Suite (VIIRS) retrieval algorithm. This study utilizes VIIRS proxy imagery and aerosol products to study this source of error. Preliminary results will be presented at the meeting. A comparison between the aerosol-corrected SST's and non-corrected SST's indicates that the VIIRS aerosol products are useful for applying aerosol correction in the SST retrieval. VIIRS will fly as a primary sensor on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program. The first opportunity for VIIRS will be as a payload on the NPOESS Preparatory Project (NPP), currently scheduled for launch in 2006.

Discussion

The VIIRS instrument resembles the MODIS instrument. In addition, VIIRS bands and algorithms are MODIS heritage. A comparison between the aerosol-corrected SST's and non-corrected SST's indicates that the MODIS aerosol products are useful for applying an aerosol correction in the MODIS SST retrieval. Sources of error may include coregistration errors which would account for differences in MODIS and VIIRS observations, differences in spatial resolution, and loss of variability in SST due to use of the mean SST.

VIIRS/MODIS Bands

VIIRS Band	Spectral Range (µm)	Nadir HSR (m)	MODIS Band (s)	Range	Nadir HSR (m)
M12	3.660-3.840	750	20	3.660-3.840	1000
M13	3.973-4.128	750	21or 22	3.929-3.989 3.929-3.989	1000
M15	10.263-11.263	750	31	10.780-11.280	1000
M16	11.538-12.488	750	32	11.770-12.270	1000

VIIRS Algorithm Description

Daytime algorithms (dual split window or sunglint split window):

$$SST = a_0 + a_1 T_{11} + a_2 T_{12} + a_3(\sec(z) - 1) + a_4 T_{3.7} + a_5 T_{4.0} + a_6 T_{3.7}\cos(zs)$$
$$+ a_7 T_{4.0}\cos(zs) + a_8(T_{11} - T_{12})^2$$

$$SST = a_0 + a_1 T_{11} + a_2(T_{11} - T_{12}) + a_3(\sec(z) - 1) + a_4(T_{11} - T_{12})^2$$

Nighttime algorithms (dual split window):

$$SST = a_0 + a_1 T_{11} + a_2 T_{12} + a_3(\sec(z) - 1) + a_4 T_{3.7} + a_5 T_{4.0} + a_6 T_{3.7}^2 + a_7 T_{4.0}^2$$
$$+ a_8(T_{11} - T_{12})^2$$

Coefficients are stratified by dry/moist, skin/bulk, day/night, temperature, aerosol type and concentration.

Figure 1. MODIS visible bands of volcanic aerosol red line marks a transect through the aerosol.
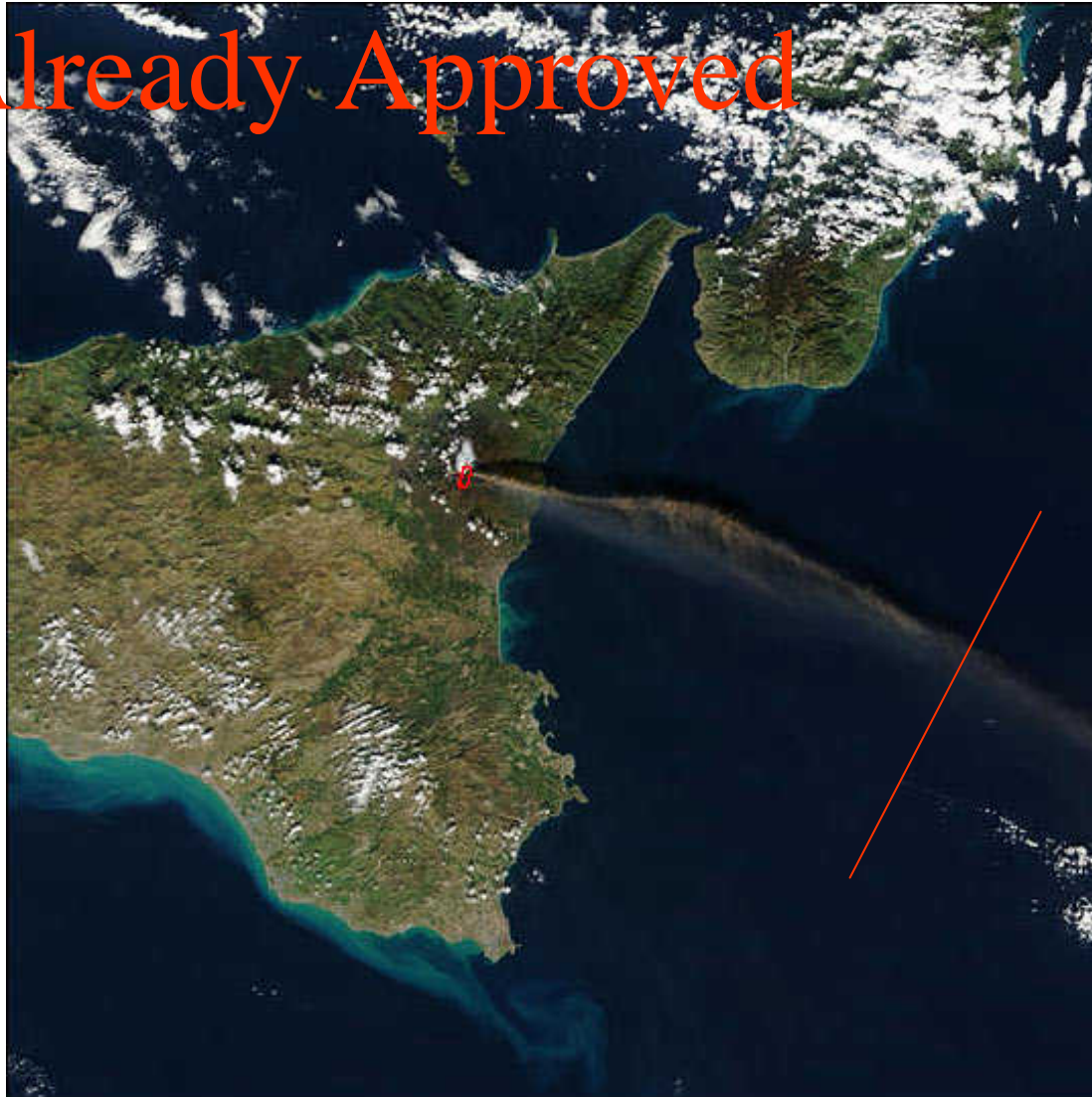
Figure 2. MODIS SST bands of volcanic aerosol of the same area as shown in the visible image. Black box marks a corresponding area transect through the aerosol.
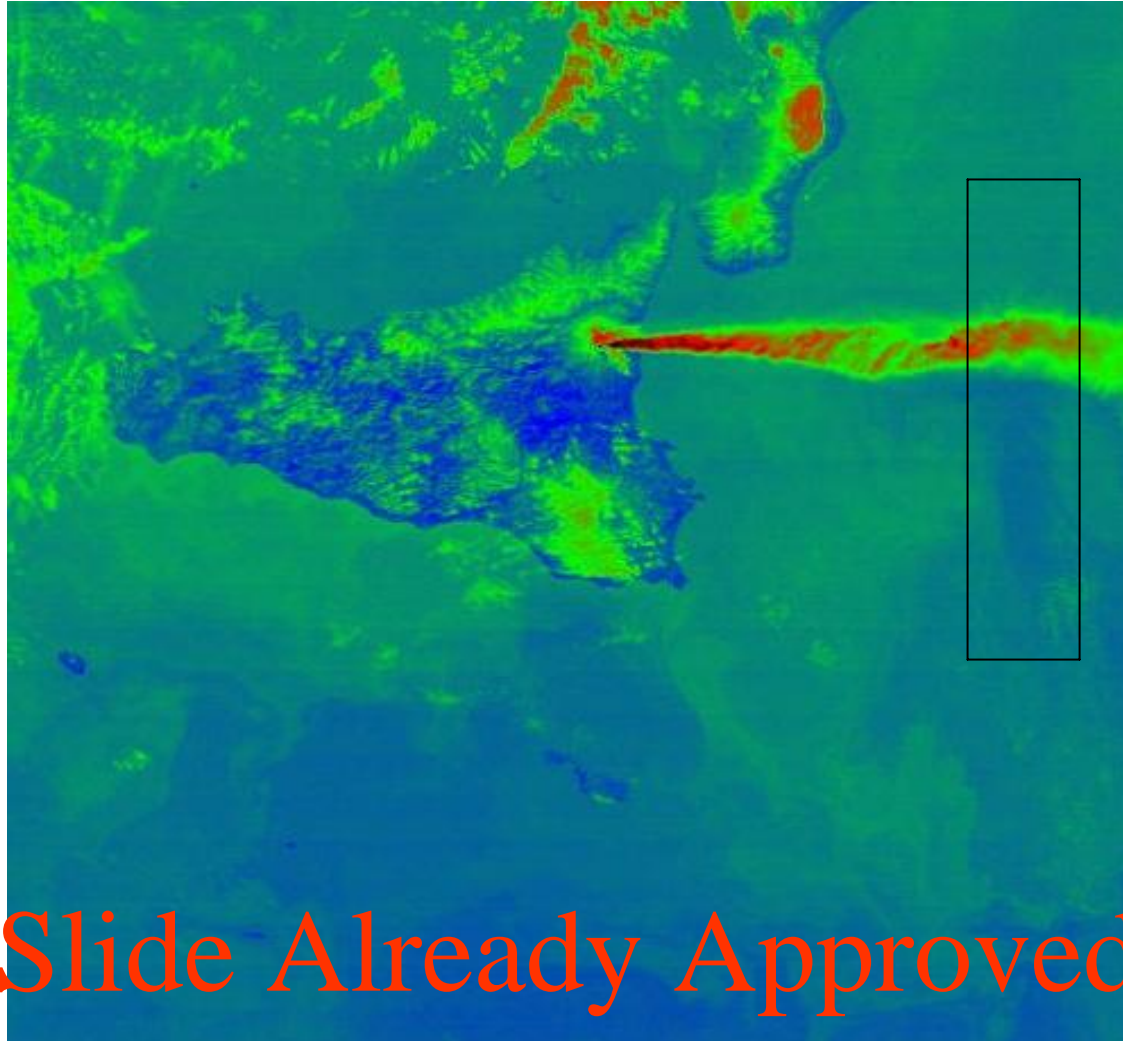
Figure 3. Profile of volcanic aerosol and SST showing the effect this type of aerosol has on SST retrievals for a cross section in the transect shown in Figure 2.
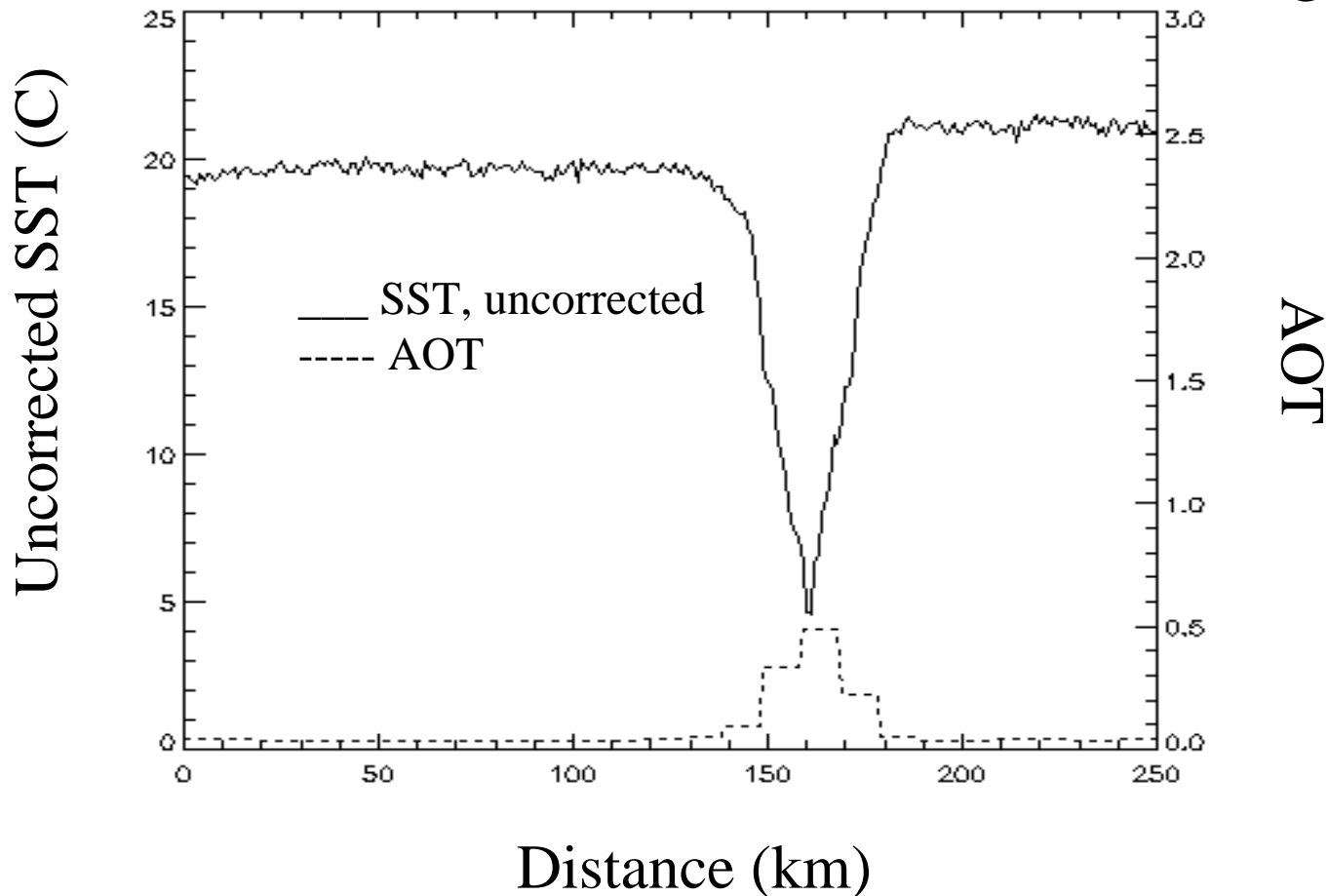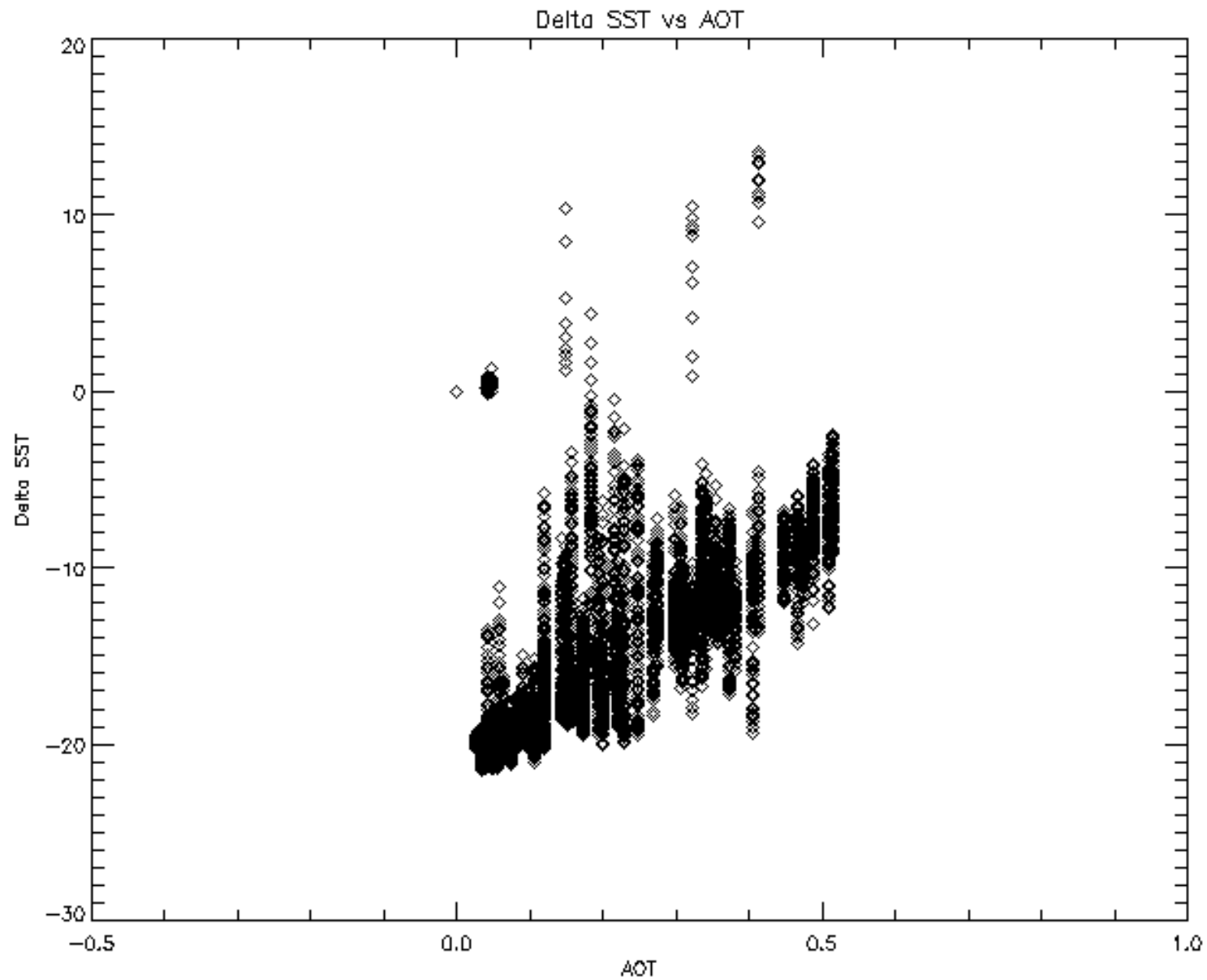
Figure 4. Delta SST vs. AOT

AOT Correction Method

$\Delta SST(i) = \text{mean } SST - SST'(i)$

$m = \text{slope}, \Delta SST/AOT \text{ (from Figure 4)}.$

$SST(i) = SST'(i) + m*\Delta SST(i)$

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Figure 4. MODIS SST data with no aerosol correction applied.
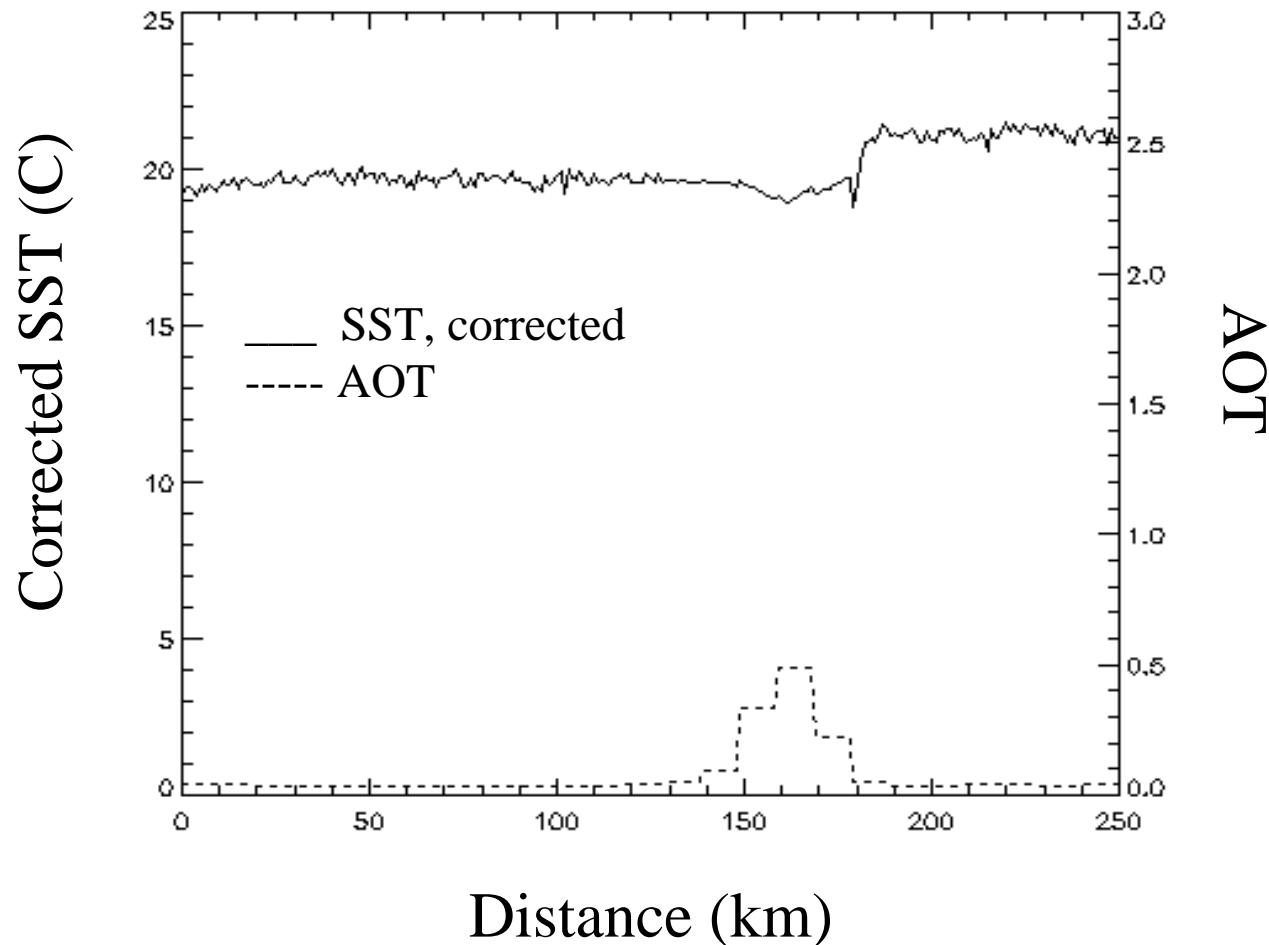
Figure 5. MODIS
AOT data
for area transect.

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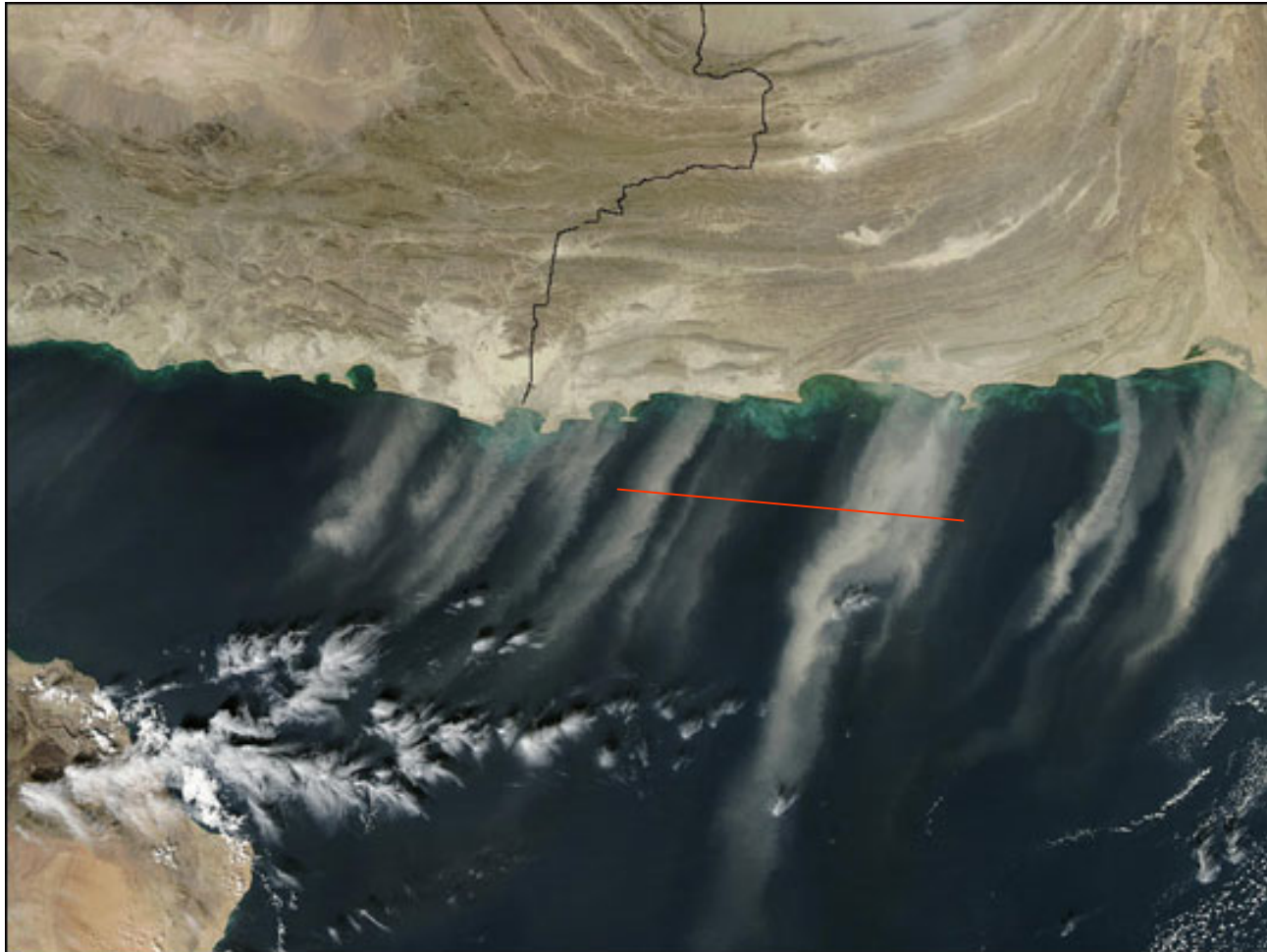
Figure 6. MODIS SST data with aerosol correction applied.
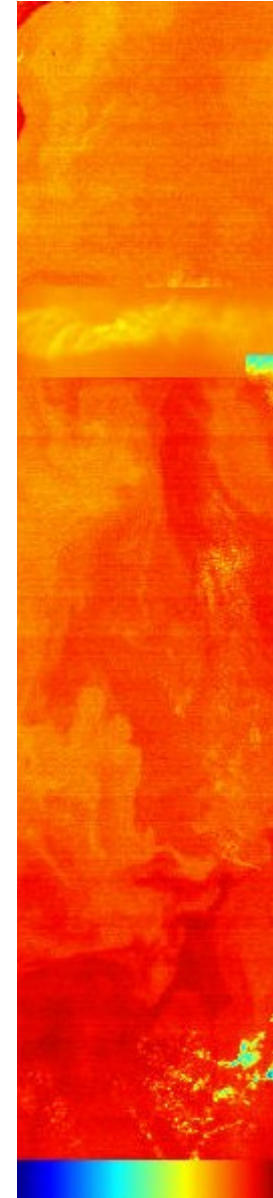
Figure 7. Profile of volcanic aerosol and corrected SST for the transect shown in Figure 2.

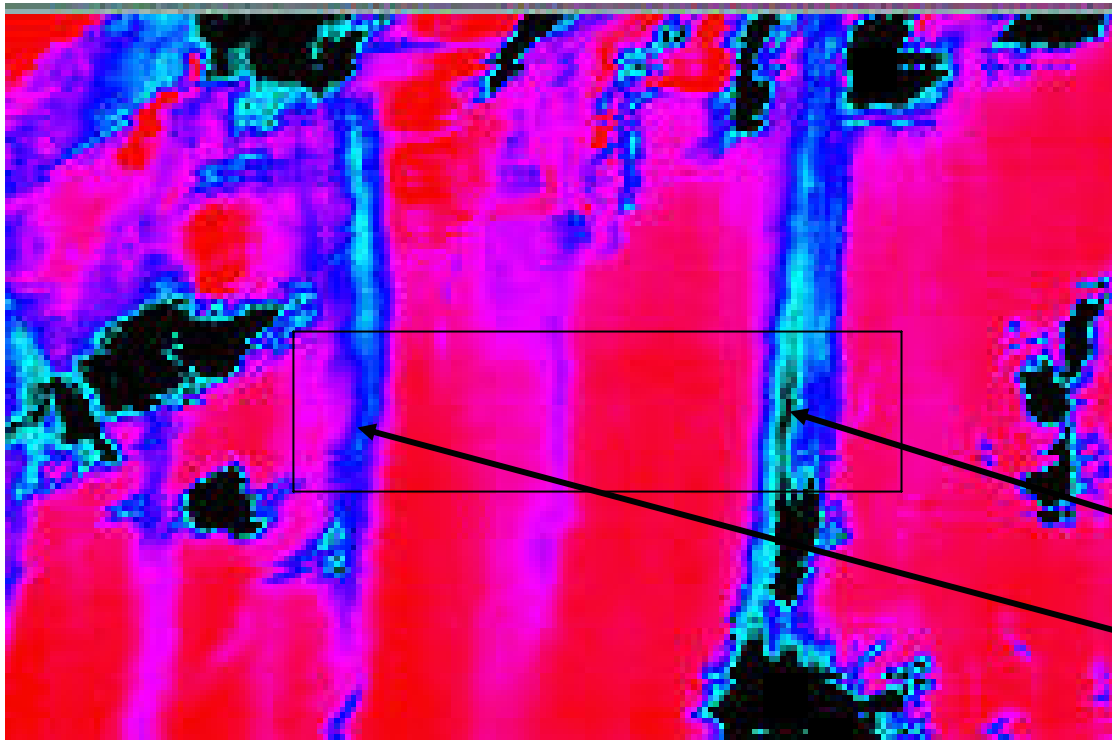Figure 8. MODIS visible bands of dust aerosol.
Red line marks a transect through the aerosol.

Figure 9. MODIS SST bands showing dust aerosol of the same region as shown in the visible image. Black box shows region of evaluation through the aerosol.

Dust plumes are indicated in blue.

Figure 11. Profile of dust aerosol and SST showing the effect this type of aerosol has on SST retrievals for a cross section in the transect shown in Figure 8.
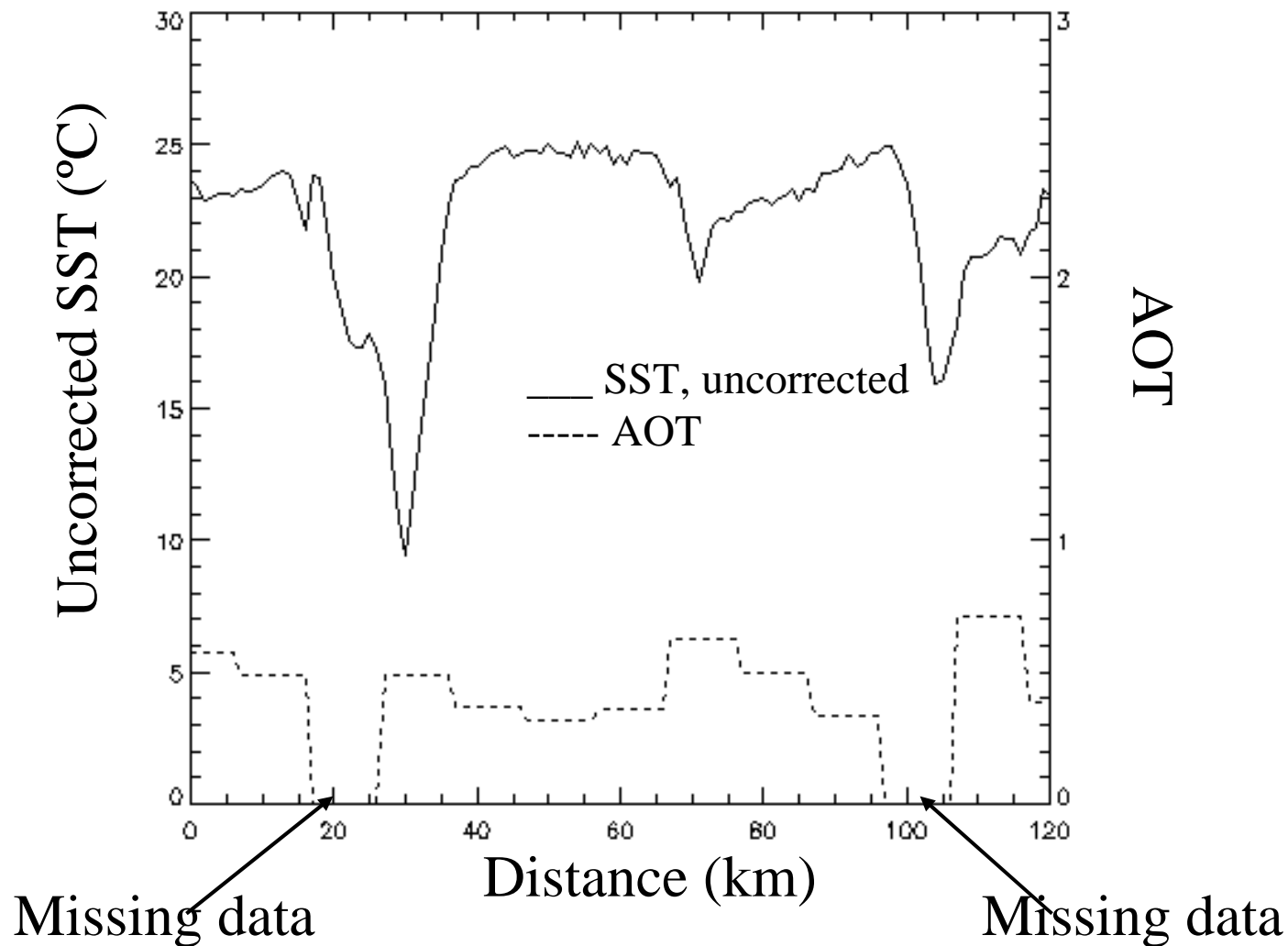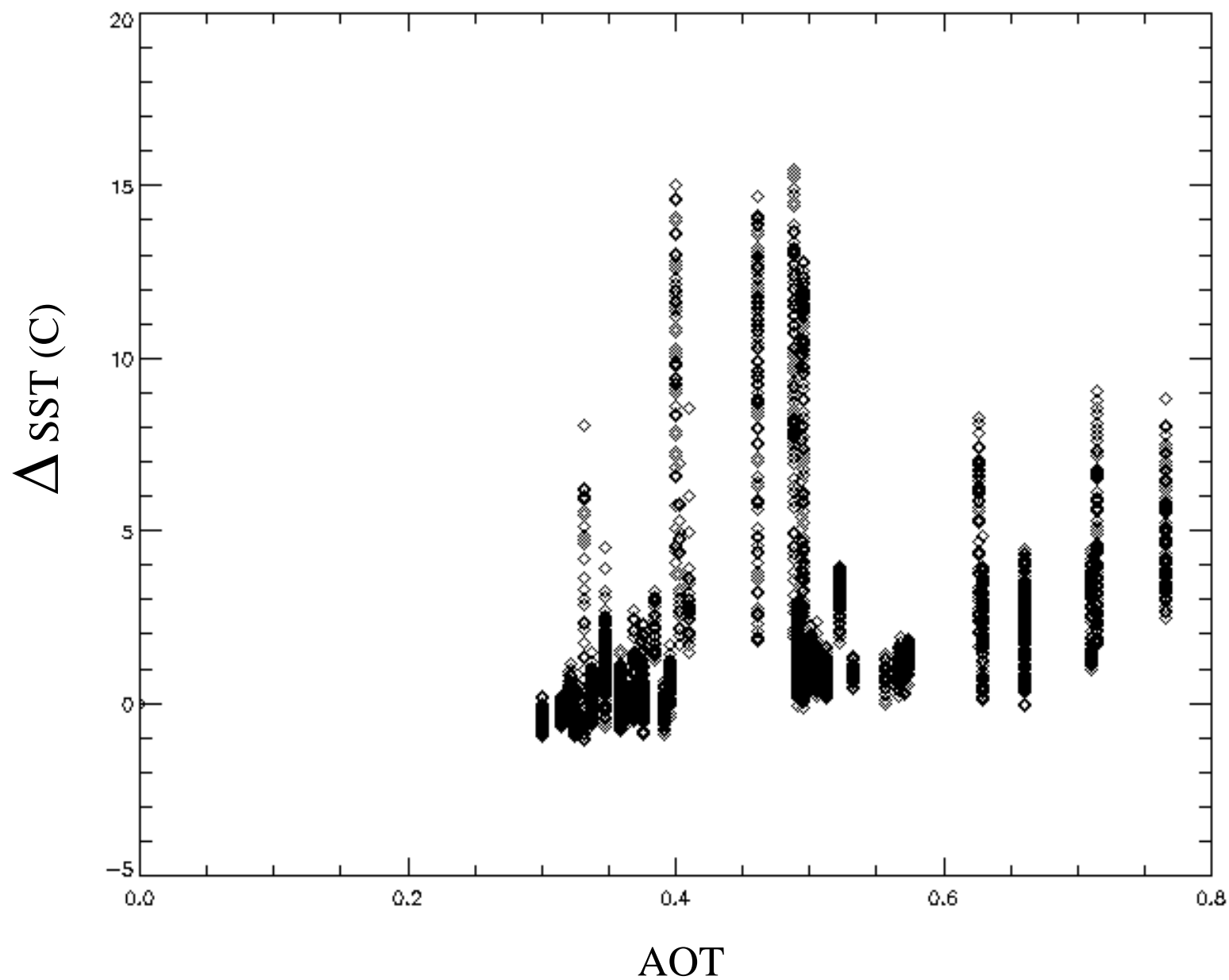
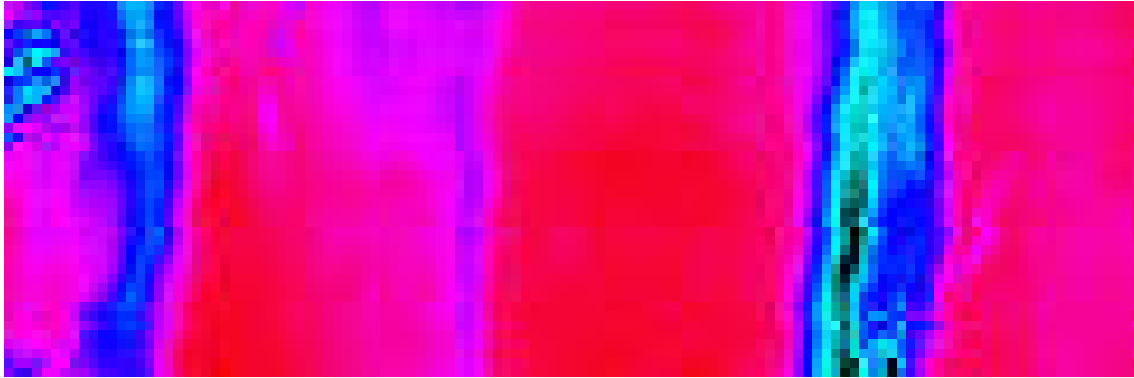Figure 12. ΔSST vs. Dust AOT

Slide Already Approved

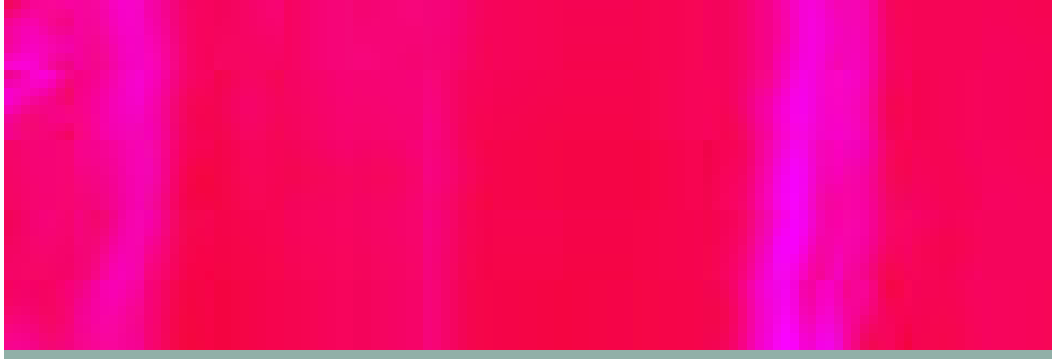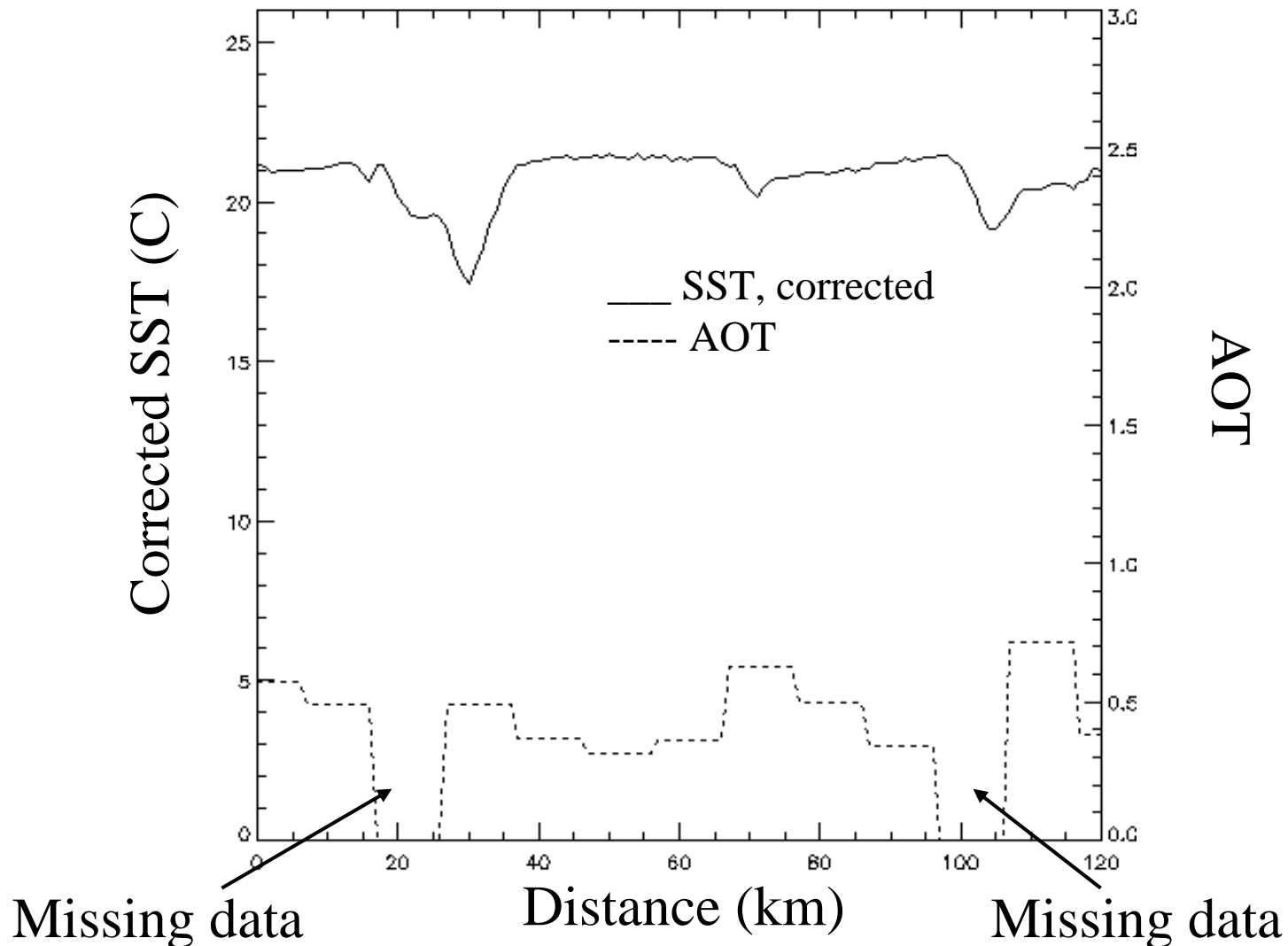Figure 10. MODIS SST data with no aerosol correction applied.

Figure 13. MODIS SST data with aerosol correction applied.

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Figure 14. Profile of dust aerosol and corrected SST for the transect shown in Figure 8.

Summary

- This preliminary study indicates that episodic aerosol events are expected to significantly impact the VIIRS SST retrievals.
- MODIS aerosol products are shown to be useful for applying an aerosol correction in the MODIS SST retrieval.
- A more comprehensive study of aerosol effects is underway to develop an operational VIIRS aerosol correction for SST.

References

VIIRS documents

[Y-2386] Visible/ Infrared Imager/ Radiometer Suite (VIIRS) Sea Surface Temperature Algorithm Theoretical Basis Document, Version 5, May 2002.

[Y-2476] Visible/ Infrared Imager/ Radiometer Suite (VIIRS) Aerosol Optical Thickness and Particle Size Parameter, Version 5, May 2002

Acknowledgements